Entergy

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J. E. Pollock
Site Vice President

NL-10-019

March 9, 2010

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Stop O-P1-17
Washington, D.C. 20555-0001

SUBJECT: Licensee Event Report # 2010-001-00, "Automatic Reactor Trip as a Result of a Turbine-Generator Trip Due to a Loss of Generator Field Excitation Caused by a Failed Exciter Rectifier"
Indian Point Unit No. 2
Docket No. 50-247
DPR-26

Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc. (ENO) hereby provides Licensee Event Report (LER) 2010-001-00. The attached LER identifies an event where the reactor was automatically tripped, which is reportable under 10 CFR 50.73(a)(2)(iv)(A). As a result of the reactor trip, the Auxiliary Feedwater System was actuated, which is also reportable under 10 CFR 50.73(a)(2)(iv)(A). This condition was recorded in the Entergy Corrective Action Program as Condition Report CR-IP2-2010-00157.

There are no new commitments identified in this letter. Should you have any questions regarding this submittal, please contact Mr. Robert Walpole, Manager, Licensing at (914) 734-6710.

Sincerely,

Thom M. Orlando
for J. Pollock

JEP/cbr

cc: Mr. Samuel J Collins, Regional Administrator, NRC Region I
NRC Resident Inspector's Office, Indian Point 2
Mr. Paul Eddy, New York State Public Service Commission
LEREvents@inpo.org

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NRR

NRC FORM 366 (9-2007) — U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES: 8/31/2010

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
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4. TITLE: Automatic Reactor Trip as a Result of a Turbine-Generator Trip Due to a Loss of Generator Field Excitation Caused by a Failed Exciter Rectifier

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV. NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
1	11	2010	2010-	001 -	00	3	09	2010		05000
									FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE: 1

10. POWER LEVEL: 100%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER *(Include Area Code)*
Robin Daley, System Engineer	(914) 734-6817

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
X	TL	RECT	G080	Y					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR

16. ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced type written lines)*

On January 11, 2010, an automatic reactor trip (RT) was initiated as a result of turbine trip due to a loss of main generator excitation. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. The Auxiliary Feedwater System automatically started as expected due to SG low level from shrink effect. Prior to the RT one of four rectifiers (#24) of the main generator excitation system was believed to be electrically isolated and its cooling was isolated to stop an existing cooling leak. Investigations determined the rectifier disconnect switch that was believed to be open remained in a closed condition. This condition allowed current to continue to flow through the 24 rectifier diodes and because there was no cooling water the diodes failed resulting in a loss of field voltage to the exciter actuating a trip signal. The direct cause of the RT was loss of generator field excitation due to loss of two diodes within the # 24 Generrex rectifier cabinet. The root cause was failure of management to implement critical decision making. A significant contributing cause was an improper lubricant used on disconnect switch contact surfaces. Corrective actions included a brief of station personnel on the event and lessons learned. A Generrex upgrade modification will be implemented including new disconnect switches in the spring 2010 refueling outage, case study training will be completed, computer based training (CBT) from the case study will be prepared and included in training curriculum, Alarm Response Procedure (2-ARP-SJF) and System Operating Procedure (2-SOP-24.4) will be revised for operation of the new disconnect switches, and maintenance personnel will be instructed on appropriate application of greases. The event had no effect on public health and safety.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

Note: The Energy Industry Identification System Codes are identified within the brackets {}.

DESCRIPTION OF EVENT

On January 11, 2010, at approximately 15:59 hours, while at 100% steady state reactor power, an automatic reactor trip (RT) {JC} was initiated as a result of turbine trip (TT) due to a trip of the Generator Backup Lockout Relay {86BU}. Relay 86BU was tripped by the actuation of the Loss of Field Relay {40}. All control rods {AA} fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. There was no radiation release. The Emergency Diesel Generators {EK} did not start as offsite power remained available. The Auxiliary Feedwater System {BA} automatically started as expected due to SG low level from shrink effect. The event was recorded in the Indian Point Energy Center corrective action program (CAP) as CR-IP2-2010-00157. A post trip evaluation was initiated and completed on January 11, 2010.

Prior to the event at approximately 15:11 hours, the 24 exciter rectifier {RECT} was believed to have been removed from service to repair a stator cooling water {TJ} leak within the 24 rectifier cabinet. The leak was discovered on January 7, 2010, and identified to be on an elbow of the cooling water return line in the 24 rectifier cabinet. Industry Generrex users and fleet Alterrex users were contacted on suggested leak monitoring and repair methods. An Operational Decision Making Issue (ODMI) action plan was prepared to monitor the leak and provide guidance on plant operation should the leak increase. On January 11, 2010, the leak had steadily increased and it was determined the leak would exceed the ODMI leak threshold for rectifier isolation by January 12, 2010, and that the rectifier should be isolated and the leak repaired. Operations established an Infrequently Performed Test or Evolution (IPTE) and conducted a brief that included industry operating experience (OE) for removing rectifiers from service. Included were the critical points where human performance tools should be emphasized.

Per direction of the ODMI, isolation of the rectifier cabinet was performed in accordance with 2-SOP-26.4 (Turbine-Generator Operating Procedure). The rectifier is first isolated electrically by opening the rectifier disconnect switch then the cooling is isolated by closing the inlet and outlet cooling water isolation valves. Isolation of the rectifier involved: 1) Opening a 5 pole disconnect switch, which opens the 3 poles to the 3-phase AC input voltage to the rectifier and the 2 poles which open the DC output from the rectifier, 2) Removal of the fuses {FU} for the circuit which provides the firing (gating) voltage for the 24 rectifier Silicon Controlled Rectifiers (SCRs), and 3) Isolating the cooling water to the rectifier cooling system. At approximately 15:11 hours, a Nuclear Plant Operator (NPO) with engineering present operated the rectifier disconnect switch by pulling down on its handle. When the NPO operated the switch the handle traveled from an upright vertical position to a horizontal position, but the NPO questioned if the switch had operated correctly. After a discussion among the personnel present it was decided to pull down on the switch handle a second time. After applying considerable force the switch remained in the same position. Based on this action, personnel at the switch concluded the switch was in the open position. Fuses for the +18 volt DC and +38 volt DC control power to the SCR gate drivers were then removed to ensure all power was removed from the cabinet before work was initiated in the cabinet. A voltage check was performed on the buswork immediately above the leaking cooling water pipe. The voltage check discovered approximately 137 volts AC phase to ground and zero volts phase to phase. Engineering discussed the voltage condition with operations and concluded it was most likely a monitoring circuit. This conclusion was based on the voltage not being a normal voltage (e.g., 120V, 240V) and that there was zero voltage phase to phase. It was also noted the diode and (SCR) monitoring lights on the rectifier cabinet were still lit.

Subsequently the cooling water to the rectifier was isolated by closing the inlet and outlet isolation valves. After approximately five minutes from when the cooling water was isolated to the rectifier, a "Rectifier High Temperature" common alarm annunciated in the control room (CR). Engineering discussed the abnormal alarm condition with operations and concluded it was due to latent heat within the cabinet and would decay with time clearing the alarm. Engineering continued investigating the source of the 137 volts AC in the cabinet when at 15:59 hours there was a RT. Removing the fuses for the 24 rectifier SCR gating voltage prevented their firing and shunting of the rectifier diodes. The condition resulted in the 24 rectifier providing maximum output current through its diodes with no cooling water available causing their failure and shorting. The shorted diodes are connected in parallel with the DC excitation voltage from the output of the other three rectifiers. The shorted diodes of the 24 rectifier caused a short across the exciter field resulting in a loss of voltage to the exciter. When there is a loss of voltage to the exciter, the Minex circuit of the exciter de-excites the generator field, actuating the exciter protective loss of field relay {40} which initiates a trip of the 86BU relay. The trip of the 86BU actuates the turbine protection system solenoid valves 20/AST and 20/ASB to dump autostop oil initiating a TT which initiated a RT.

Following the unit trip, an investigation determined that the 24 rectifier 5 pole disconnect switch that was supposed to be in an open position was actually still in the closed position. Once the cooling to the rectifier was isolated the diode and SCR stacks in the cabinet overheated and two diodes in series electrically failed (shorted) and caused a loss of generator field excitation. The investigation also discovered the grease used in a 2008 Preventive Maintenance (PM) to lubricate the switch contacts developed a tacky consistency effectively gluing the disconnects shut.

Unit 2 has a General Electric Exciter-Generator {TB} coupled to a Westinghouse Turbine {TA}. The Generrex is a main generator exciter {TL} regulating device for producing the main generator field and is manufactured by General Electric Company {G080}. The Generator rotor is hydrogen cooled and the stator is water cooled. The Generrex system is a compound potential source exciter that utilizes three transformers {XFMR} housed above the main generator to obtain excitation power from additional stator bars (P-Bars) in the generator. AC power flows from the P-Bars into the transformers which, when the generator is excited, supply enough voltage to fulfill the maximum possible field voltage at all times of operation. The main generator excitation system (Generrex) consists of four parallel rectifier {RECT} bridges. The design provides sufficient capacity to carry full generator output under all steady state and fault conditions with one rectifier bridge out of service for maintenance. The Generrex rectifiers have forward and reversed biased diodes connected to the incoming 3-phase 480 volt AC power {EC}. The output of the rectifiers is a DC voltage that supplies the main generator exciter. The SCRs are fired to regulate the output current of the rectifier by shunting the rectifier diodes. The rectifier is designed such that a single bridge/cabinet can be removed from service and its cooling water isolated and the unit can continue to operate at 100%.

The disconnect switches are high pressure contact 5-pole switches (3 AC stabs, 2 DC stabs). The disconnect switch is manufactured by Kam-Loc. The switches utilize a cam-based hinge with a non-conductive handle. The high pressure disconnect is a unique type of disconnect which uses a spring lock tension device. The handle has two specific detents during its travel from closed to open. Opening the handle to the first detent relieves the spring pressure internally, unlocking the switch. Moving the switch to the second detent physically opens the switch, separating the conducting fingers and providing an electrical break.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

The rectifier cooling water is supplied by the Main Stator Cooling Water {TJ} skid, which cools the main generator windings. The rectifier cabinets have their own supply header which provides approximately 15 gpm of de-ionized water to each bridge continuously.

An extent of condition investigation determined the condition is only applicable to the four rectifier cabinets of the Generrex system.

Cause of Event

The direct cause of the RT was a loss of generator field as a result of the failure of two diodes in series within the 24 rectifier cabinet. The root cause was failure of management to implement critical decision making. An aggregate of contributing causes set the team up for failure but there were multiple opportunities during the evolution to stop and reassess the conditions that were found prior to continuing and isolating the cooling to the rectifier. The IPTE established for the evolution specifically stated the rectifier should be verified de-energized before isolating the cooling water. However, the team did not stop and re-assess the conditions that were found prior to proceeding. Conditions did exist to indicate the rectifier was energized and cooling water should not be isolated. The status of the diode and SCR lights was also not properly questioned by the team. When confronted with unexpected conditions the team should have stopped and evaluated the as-found data.

Significant contributing causes (CC): CC1: Improper lubricating grease used during previous PM. When the rectifier disconnects were repaired and cleaned in the spring 2008 refueling outage, the fingers were coated with a grease manufactured by WITCO for Siemens circuit breakers. An investigation determined this grease is not meant for disconnect switch contact surfaces. Per the breaker vendor manual this conductive grease is for sliding metal surfaces within a circuit breaker and specifically not meant to be applied on contact surfaces. It is possible that the normal temperatures inside the rectifier cabinet caused the grease to bake into a hardened substance. The name of the grease is "Contact Lubricant," which is misleading and may have contributed to its misuse. CC2: Lack of operator/engineer familiarity with the operation of the switches. The high pressure disconnect is a unique type in that it has two detents on its travel from closed to open. To an operator that has not seen this switch operated it may not be obvious that the switch is still closed at the first detent. NPO qualification training does not include details of the switch to clarify their positions to operators who would not normally see them manipulated.

Corrective Actions

The following corrective actions have been or will be performed under Entergy's Corrective Action Program to address the cause and prevent recurrence:

- The leaking cooling water elbow in the 24 rectifier cabinet was replaced and the cooling water in the cabinet restored to satisfactory operation. The rectifier was left de-energized.
- The rectifier disconnect switch contacts were cleaned.
- An all hands meeting was performed and the Station Event Free Clock reset. Personnel were briefed on the event and lessons learned and management expectation that when unexpected conditions are found, stop, notify plant supervision and re-assess before proceeding.
- A Generrex upgrade modification that will include repair of the rectifier and installation of new disconnect switches. Implementation is scheduled in the spring 2010 refueling outage.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

- Procedures 2-ARP-SJF and 2-SOP-26.4 will be revised to include operation of the new disconnect switches being installed by the Generrex upgrade modification. Scheduled completion date is April 9, 2010.
- Operations crews will be given just-in-time training (JIT) on the operation of the new disconnect switches and new operating guidelines included in NPO qualification training. Scheduled completion date is April 9, 2010.
- Maintenance personnel will be instructed on appropriate application of greases and an EOC performed to determine where else Siemens grease was applied other than its intended application. Scheduled completion date is May 31, 2010.
- A case study of the event will be developed focusing on human performance aspects and distributed to operations, training, and maintenance personnel and included in quarterly training curriculum for engineers (ESP-4). Distribution and inclusion in training curriculum is scheduled to be completed by June 30, 2010.
- Computer based training (CBT) will be developed from the case study and supervisors and above will complete the CBT. Scheduled date of completion is August 31, 2010.
- A TEAR (Training Evaluation and Action Request) will be initiated to include the case study in the operations and maintenance training programs. Scheduled date of TEAR initiation is June 30, 2010.
- Training of Operations, Maintenance and Engineering on the case study is scheduled to be completed by December 31, 2010.

Event Analysis

The event is reportable under 10CFR50.73(a)(2)(iv)(A). The licensee shall report any event or condition that resulted in manual or automatic actuation of any of the systems listed under 10CFR50.73(a)(2)(iv)(B). Systems to which the requirements of 10CFR50.73(a)(2)(iv)(A) apply for this event include the Reactor Protection System (RPS) including RT and AFWS actuation. This event meets the reporting criteria because an automatic RT was initiated at 15:59 hours, on January 11, 2010, and the AFWS actuated as a result of the RT. On January 11, 2010, at 18:31 hours, a 4-hour non-emergency notification was made to the NRC for an actuation of the reactor protection system {JC} while critical under 10CFR50.72(b)(2)(iv) and included an 8-hour notification under 10CFR50.72(b)(3)(iv)(A) for a valid actuation of the AFW System (Event Log #45624). As all primary safety systems functioned properly there was no safety system functional failure reportable under 10CFR50.73(a)(2)(v).

Past Similar Events

A review was performed of the past three years for Licensee Event Reports (LERs) reporting a RT from a Generrex Main Generator protective trip. The review identified LER-2006-005 and LER-2009-005. LER-2006-005 reported a RT on November 15, 2006, due to a main generator protective trip during troubleshooting of the Generrex exciter power supply. The cause was determined to be a loss of ground to the alarm cards due to high resistance connections on regulator circuit cards. LER-2009-005 reported a RT on November 2, 2009, due to a Generrex protective trip (86P Lockout Relay). The cause of the event was a poor Original Equipment Manufacturer (OEM) design of the common ground wiring connections on the Generrex power supply distribution block. The cause of the events reported in LER-2006-005 and LER-2009-005 were different and the corrective actions for those events would not have prevented this event.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

Safety Significance

This event had no effect on the health and safety of the public. There were no actual safety consequences for the event because the event was an uncomplicated reactor trip with no other transients or accidents. Required primary safety systems performed as designed when the RT was initiated. The AFWS actuation was an expected reaction as a result of low SG water level due to SG void fraction (shrink), which occurs after a RT and main steam back pressure as a result of the rapid reduction of steam flow due to turbine control valve closure.

There were no significant potential safety consequences of this event under reasonable and credible alternative conditions. The RPS is designed to actuate a RT for any anticipated combination of plant conditions including a direct RT on TT unless the reactor is below approximately 20% power (P-8). The analysis in UFSAR Section 14.1.8 concludes an immediate RT on TT is not required for reactor protection. A RT on TT is provided to anticipate probable plant transients and to avoid the resulting thermal transient. If the reactor is not tripped by a TT, the over temperature delta temperature (OTDT) or over power delta temperature (OPDT) trip would prevent safety limits from being exceeded. The generator is protected by the generator protection system (GPS) which is designed to protect the generator from internal and external faults by tripping the output breakers. During this event the GPS functioned as designed and initiated a TT. This event was bounded by the analyzed event described in UFSAR Section 14.1.8 (Loss of External Electrical Load). The response of the plant is evaluated for a complete loss of steam load from full power without a direct RT and includes the acceptability of a loss of steam load without direct RT on turbine trip below 35 percent power. The analysis shows that the plant design is such that there would be no challenge to the integrity of the reactor coolant system or main steam system and no core safety limit would be violated. The RT and the reduction in SG level is also a condition for which the plant is analyzed. A low water level in the SGs initiates actuation of the AFWS. The AFW System has adequate redundancy to provide the minimum required flow assuming a single failure. The analysis of a loss of normal FW (UFSAR Section 14.1.9) shows that following a loss of normal FW, the AFWS is capable of removing the stored and residual heat plus reactor coolant pump waste heat thereby preventing either over pressurization of the RCS or loss of water from the reactor. For this event, rod control was in automatic and all rods inserted upon initiation of the reactor trip. The AFWS actuated and provided required FW flow to the SGs. RCS pressure remained below the set point for pressurizer PORV or code safety valve operation and above the set point for automatic safety injection actuation. Following the RT, the plant was stabilized in hot standby.